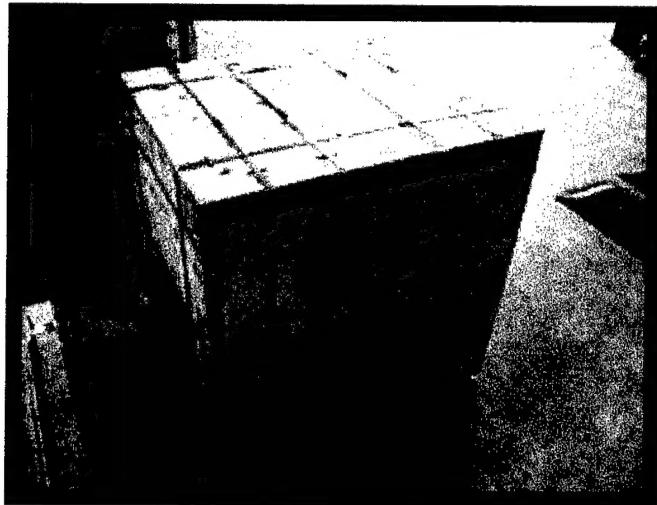


**FINAL REPORT  
MAY 2004**

**REPORT NO. 04-17**



**SURE-LOK, STYLE II CONTAINER, 40" x 48",  
MIL-STD-1660 TESTS**

Prepared for:

Distribution Unlimited

Action Wood Technologies, Inc.  
44311 Reynolds Drive  
Clinton Township, MI 48036



[REDACTED]

**VALIDATION ENGINEERING DIVISION  
MCALESTER, OKLAHOMA 74501-9053**

**20040601 043**

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**REPORT NO. 04-17  
SURE-LOK STYLE II CONTAINER, 40"x 48",  
MIL-STD-1660 TESTS**

**MAY 2004**

**ABSTRACT**

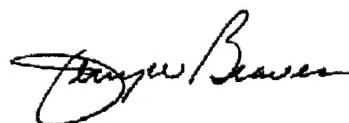
The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV) conducted MIL-STD-1660, "Design Criteria for Ammunition Unit Loads" on the SURE-LOK, Style II, 40" x 48", Container manufactured by Action Wood Technologies, Inc., from Clinton Township, Michigan. Two containers were tested. The containers were loaded and passed with a load of 4,080 lbs and 4,075 lbs, respectively. The tests accomplished on the test units were the stacking, vibration, edgewise rotational drop, incline impact, sling compatibility, forklift handling, pallet truck, and disassembly tests. The containers passed all requirements with no significant problems encountered. As a result of the performance of the container, the SURE-LOK, Style II, 40" x 48", Container manufactured by Action Wood Technologies Inc., is suitable for United States Army use in such applications as retrograde repacking operations.

Prepared by:



JEFFERY L. DUGAN  
Validation Engineer

Reviewed by:



JERRY W. BEAVER  
Chief, Validation Engineering Division

**U.S. ARMY DEFENSE AMMUNITION CENTER**

**VALIDATION ENGINEERING DIVISION  
MCALESTER, OK 74501-9053**

**REPORT NO. 04-17**

**SURE-LOK, STYLE II CONTAINER, 40"x 48",  
MIL-STD-1660 TESTS**

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## **PART 1 – INTRODUCTION**

**A. BACKGROUND.** The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMPC-DEV) conducted MIL-STD-1660, "Design Criteria for Ammunition Unit Loads" on the SURE-LOK, Style II, 40" x 48", Container manufactured by Action Wood Technologies, Inc., from Clinton Township, Michigan. Two containers were loaded, tested and passed with loads of 4,080 lbs and 4,075 lbs, respectively. The tests accomplished on the test units were the stacking, vibration, edgewise rotational drop, incline impact, sling compatibility, forklift handling, pallet truck, and disassembly tests. The unitization procedures were provided by DAC, Transportation Engineering Division (SJMPC-DET).

**B. AUTHORITY.** This test was conducted IAW mission responsibilities delegated by the U.S. Army Joint Munitions Command (JMC), Rock Island, IL. Reference is made to the following:

1. AR 740-1, 15 June 2001, Storage and Supply Activity Operation
2. OSC-R, 10-23, Mission and Major Functions of the U.S. Army Defense Ammunition Center (DAC) 21 Nov 2000.

**C. OBJECTIVE.** The objective of the tests was to determine if the SURE-LOK, Style II Container met the MIL-STD-1660 test requirements prior to the acceptance of the unitization procedures by the U.S. Army.

**D. CONCLUSION.** As a result of the performance of the container, the SURE-LOK, Style II, 40" x 48", Container manufactured by Action Wood Technologies Inc., is suitable for United States Army use in such applications as retrograde repacking operations.

## **PART 2 - ATTENDEES**

### **DATE PERFORMED:**

Test Unit #1- 23 March 2004

Test Unit #2- 23-24 March 2004

Test Unit #3- Not Tested

### **ATTENDEES**

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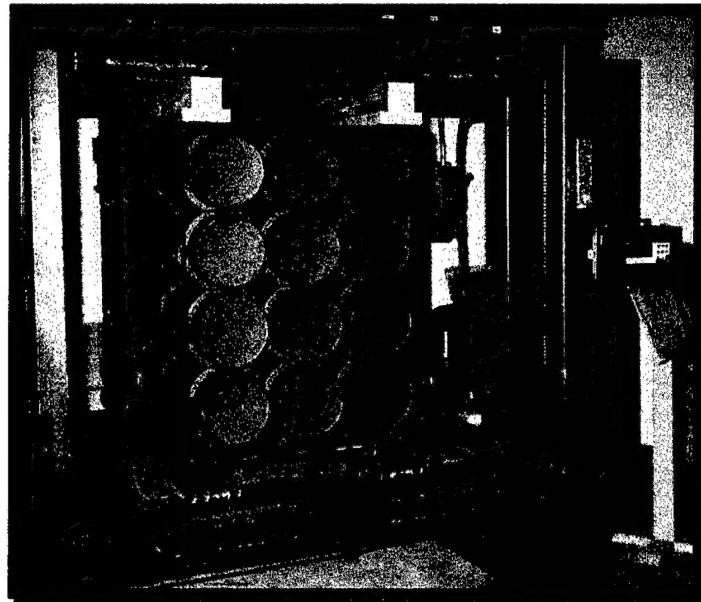
Director  
U.S. Army Defense Ammunition Center  
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Mollewood Export, Inc.  
24101 Hoover Road  
Warren, Michigan 48089

## **PART 3 - TEST PROCEDURES**

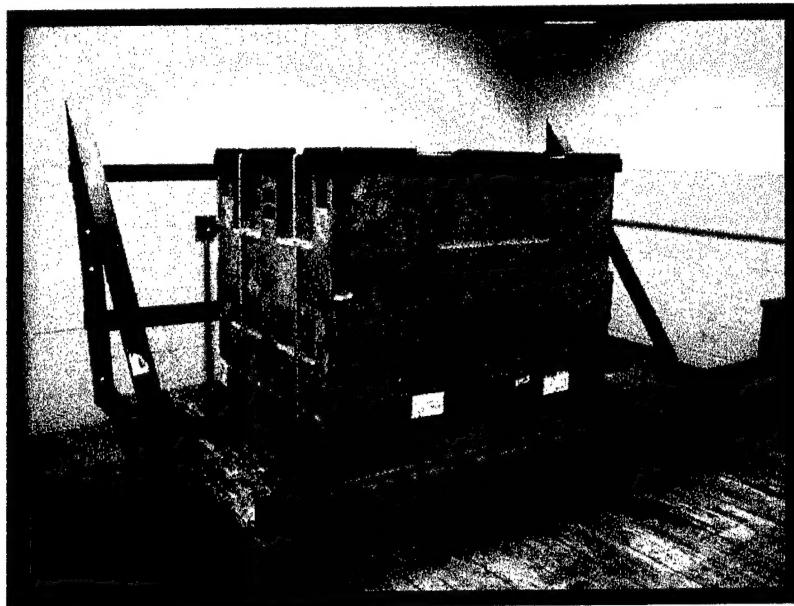
The test procedures outlined in this section were extracted from the MIL-STD-1660, "Design Criteria for Ammunition Unit Loads," 8 April 1977. This standard identifies steps that a unitized load must undergo if it is to be considered acceptable. The eight tests normally conducted on the test specimen are summarized below.

**A. STACKING TEST.** The specimen will be tested to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load will be simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. Photo 1 below shows an example of a unit load in the compression tester.



**Photo 1. Example of Compression Tester.  
(2.75-inch Hydra 70, PA151 Rocket Pallet in the compression tester.)**

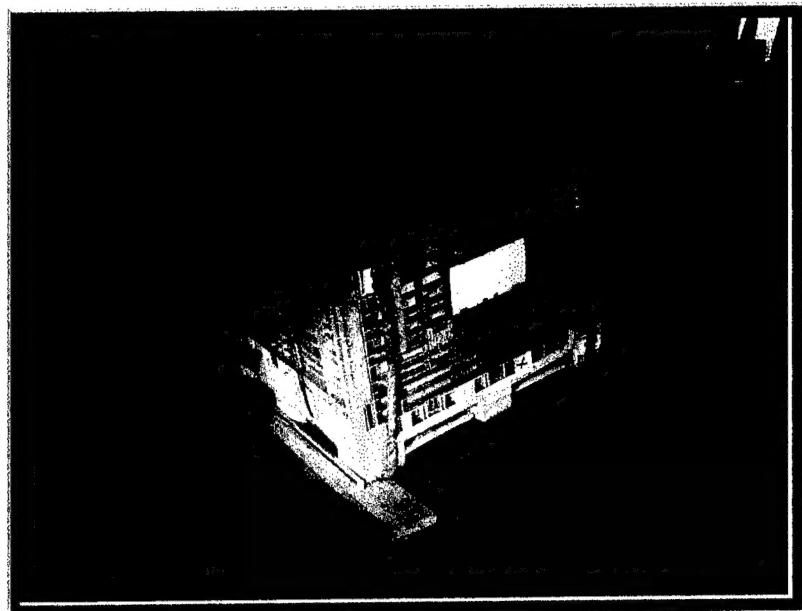
**B. REPETITIVE SHOCK TEST.** The repetitive shock test is conducted IAW Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen will be placed on (not fastened to) the platform. With the load in one position, the platform will be vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of approximately 3 cycles-per-second. The frequency will be steadily increased until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle. Midway into the testing period, the specimen will be rotated 90 degrees, and the test continued for the duration. Unless failure occurred, the total time of vibration will be three hours. Photo 2 shows an example of the repetitive shock test.



**Photo 2. Example of the Repetitive Shock Test.  
(Plastic Gemini Pallet Box)**

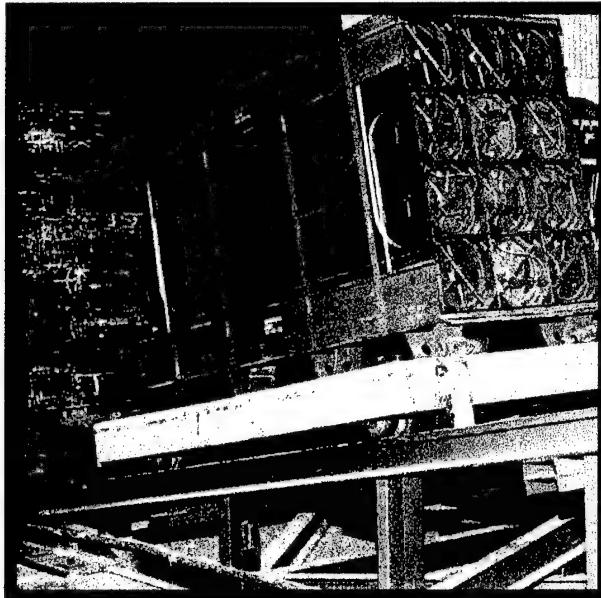
C. **EDGEWISE ROTATIONAL DROP TEST.** This test is conducted using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen will be placed on its skids with one end of the pallet supported on a beam 6 inches high. The height of the beam will be increased as necessary to ensure that there is no support for the skids between the ends of the specimen when dropping takes place, but was not high enough to cause the specimen to slide on the supports when the dropped end is raised for the drop. The unsupported end of the specimen is then raised and allowed to fall freely to the concrete, pavement, or similar unyielding surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection conforms to the following tabulation:

<b>GROSS WEIGHT (WITHIN RANGE LIMITS) (Pounds)</b>	<b>DIMENSIONS OF ANY EDGE, HEIGHT OR WIDTH (WITHIN RANGE LIMITS) (Inches)</b>	<b>HEIGHT OF DROPS ON EDGES</b>	
		<b>Level A (Inches)</b>	<b>Level B (Inches)</b>
150-250	60-66	36	27
250-400	66-72	32	24
400-600	72-80	28	21
600-1,000	80-95	24	18
1,000-1,500	95-114	20	16
1,500-2,000	114-144	17	14
2,000-3,000	Above 145- No limited	15	12
Above – 3,000		12	9



**Photo 3. Example of Edgewise Rotational Drop Test  
(Plastic XYTEC 4845 Pallet Box)**

D. **INCLINE-IMPACT TEST.** This test is conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The specimen is placed on the carriage with the surface or edge to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage will be brought to a predetermined position on the incline and released. If it were desired to concentrate the impact on any particular position on the container, a 4- x 4-inch timber may be attached to the bumper in the desired position before the test. The carriage struck no part of the timber. The position of the container on the carriage and the sequence in which surfaces and edges were subjected to impacts may be at the option of the testing activity and dependent upon the objective of the test. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen will be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at the time of the impact was 7 feet-per-second. Photo 4 shows an example of this test.



**Photo 4. Example of the Incline-Impact Test.  
(2.75-Inch, Hydra 70, PA151 Rocket Pallet on incline-impact tester.)**

**E. FORKLIFTING TESTS.** The specimen shall be lifted clear of the ground by a forklift from the end of the specimen and transported on the forks in the level or back-tilt position across a hard pavement for a distance of not less than 100 feet. The forklift will pass over the forklift hazard course as outlined in MIL-STD-1660. The hazard course will consist of parallel pairs of 1-inch boards spaced 54 inches apart and will be laid flatwise on the pavement across the path of the forklift. The first pair will be placed securely across the forklift's path and centered 30 feet from the starting point; the second pair will be laid 60 feet from the starting point at an angle of approximately 60 degrees to the path so the first wheel strikes first; and the third pair will be laid 90 feet from the starting point approximately 75 degrees to the path so the right wheel strikes first. The forklift will pass over the forklift hazard course 3 times in approximately 23 seconds, and then be brought to a stop. The load shall be observed for deflection and damage. The specimen will be rotated 90 degrees and the load lifted from the side and the above steps repeated.

**F. PALLET TRUCK TEST.** The specimen shall be lifted clear of the ground, transported a distance of at least 50 feet, and lowered. The test shall be repeated for each side of the specimen,

**G. SLING COMPATIBILITY TEST.** The specimen utilizing special design or non-standard pallets will be lifted, swung, lowered and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings will be easily attached and removed. Danger of slippage or disengagement when load is suspended will be cause for rejection of the specimen.

**H. DISASSEMBLY TEST.** Following all rough handling tests the specimen may be squared up within 2 inches of its original shape and on a flat level surface. The strapping will then be cut and removed from the palletized load. Assembly of the load will be such that it retains its unity upon removal of the strapping.

## **PART 4 - TEST EQUIPMENT**

### **A. COMPRESSION TESTER.**

1. Nomenclature	Compression Table
2. Manufacturer:	Ormond Manufacturing
3. Platform:	60- by 60-inches
4. Compression Limit:	50,000 pounds
5. Tension Limit:	50,000 pounds

### **B. TRANSPORTATION (REPETITIVE SHOCK) SIMULATOR.**

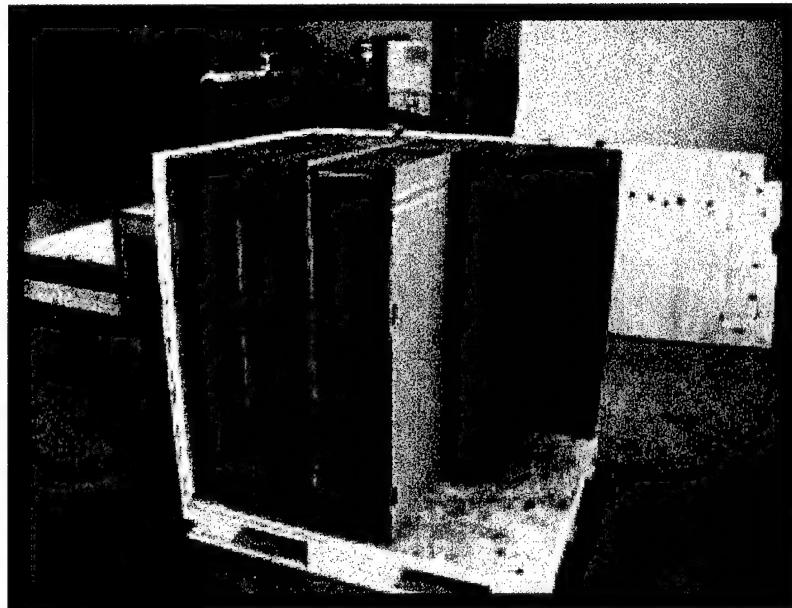
1. Nomenclature	Repetitive Shock Simulator
2. Manufacturer:	Gaynes Laboratory
3. Capacity:	6,000-pound payload
4. Displacement:	1/2-inch amplitude
5. Speed:	50 to 400 RPM
5. Platform:	5- by 8-foot

### **C. INCLINED PLANE.**

1. Nomenclature	Incline Plane Impact Tester
2. Manufacturer:	Conbur Incline
3. Type:	Impact Tester
4. Grade:	10 percent incline
5. Length:	12-foot

## PART 5 - TEST RESULTS

A. **CONTAINER DATA.** The test units were inertly loaded to the specified design weight. Special care was taken to ensure that each individual interior ammunition container had the proper amount of weight in order to achieve a realistic pallet center of gravity (CG). Once properly prepared, the test unit was tested using MIL-STD-1660, "Design Criteria for Ammunition Unit Loads," requirements. Photo 5 shows the container during loading.



**Photo 5. Container During Loading Process.**

### **TEST UNIT #1:**

Test Date: 23 March 2004  
Weight: 4,080 pounds  
Length: 48 inches  
Width: 40 inches  
Height: 50-1/4 inches

Container inertly loaded with:  
30 M548 Boxes loaded to 126  
pounds each with sand, gravel  
and scrap metal

**TEST UNIT #2:**

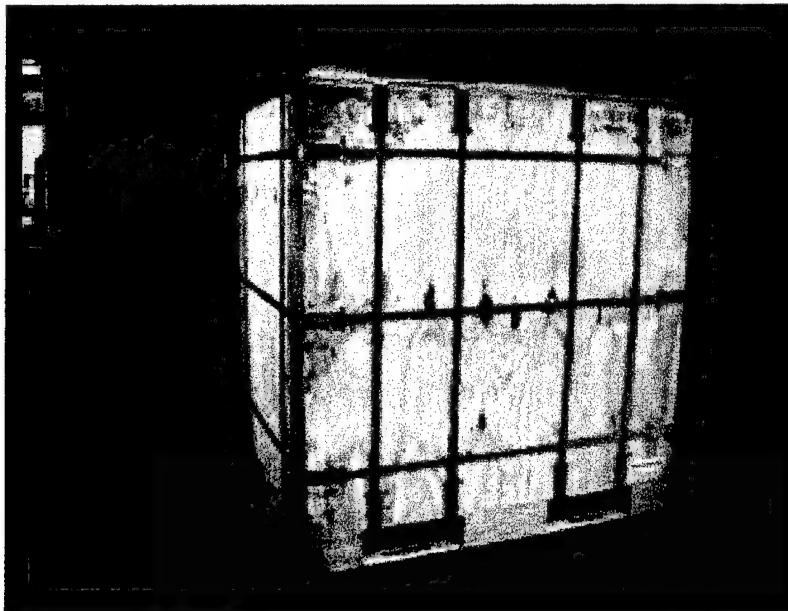
Test Dates:	23-24 March 2004	<u>Container inertly loaded with:</u>
Weight:	4,075 pounds	30 M548 Boxes loaded to 126
Length:	48 inches	pounds each with sand, gravel
Width:	40 inches	and scrap metal
Height:	50-1/4 inches	

**TEST UNIT #3:**

Test Date:	Not Tested
Weight:	Not Loaded
Length:	48 inches
Width:	40 inches
Height:	51-1/4 inches

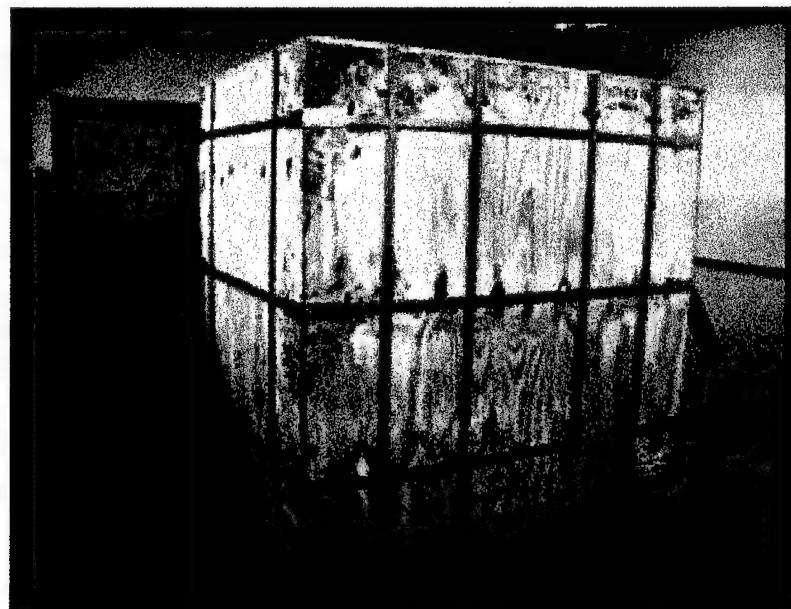
**B. TEST RESULTS of TEST UNIT #1:**

1. **COMPRESSION TEST.** Test Unit #1 was compressed with a load force of 12,250 pounds for 60 minutes on 23 March 2004. There was no damage noted to the test unit as a result of this test. See Photo 6 below for a typical picture of the test unit in the compression tester.



**Photo 6. Test Setup for Compression Testing.**

**2. REPETITIVE SHOCK TEST.** Test Unit #1 was vibrated 90 minutes at 215 RPM in the longitudinal orientation and 90 minutes at 220 RPM in the lateral orientation on 23 March 2004. There was no apparent damage sustained during this test. See Photo 7 for the test setup for the vibration test.



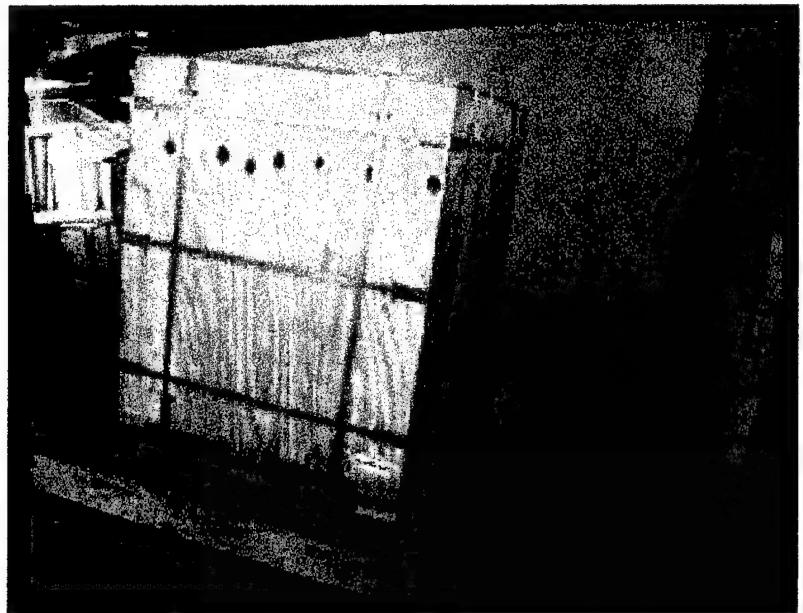
**Photo 7. Test Setup for Vibration Tests.**

**3. EDGEWISE ROTATIONAL DROP TEST.** Test Unit #1 was edgewise rotationally dropped from a height of 12 inches on both longitudinal sides and both lateral sides. No damage was noted from this test. See Photo 8 for the test setup for the drop tests.



**Photo 8. Test Setup for Drop Testing.**

**4. INCLINE-IMPACT TEST.** Test Unit #1 was incline-impacted on all four sides with the pallet impacting the stationary wall from a distance of 8 feet. No additional problems were encountered. See Photo 9 for test setup for incline-impact testing.



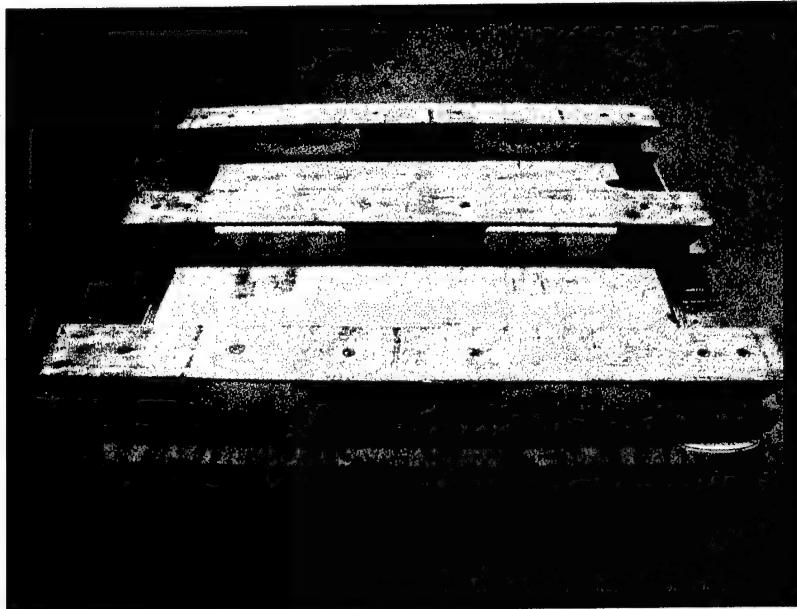
**Photo 9. Test Setup for Incline-Impact Testing.**

**5. FORKLIFTING TEST.** Test Unit #1 was lifted from the end of the pallet on the forks of the forklift truck and carried over the hazard course three times with no damage or instability noted. The test unit was lifted from the opposite end of the pallet and the above steps accomplished with no problems encountered. See Photo 10 for the test setup during the forklifting test.



**Photo 10. Test Setup for Forklift Testing.**

**6. PALLET TRUCK TEST.** Test Unit #1 was lifted and transported a distance of 50 feet and lowered. These steps were repeated for each side of the pallet with no problems noted. See Photo 11 for the pallet skid used for the SURE-LOK, Style II container.



**Photo 11. Skid Design Used for SURE-LOK, Style II Container.**

**7. SLING COMPATIBILITY TEST.** Test Unit #1 was sling compatibility tested by slinging the container with two, 10-foot slings through the sling notches at the skids. No problems were encountered during the lifts.

**8. DISASSEMBLY TEST.** During the disassembly of Test Unit #1 no additional problems were noted.

**9. CONCLUSION.** Test Unit #1 passed all required tests.

**C. TEST RESULTS of TEST UNIT #2:**

**1. COMPRESSION TEST.** Test Unit #2 was compressed with a load force of 12,250 pounds for 60 minutes on 23 March 2004. No damage was noted as a result of this test.

**2. REPETITIVE SHOCK TEST.** Test Unit #2 was vibrated 90 minutes at 215 RPM in the longitudinal orientation and 220 RPM in the lateral orientation. No damage was noted as a result of this test.

**3. EDGEWISE ROTATIONAL DROP TEST.** Test Unit #2 was edgewise rotationally dropped from a height of 12 inches on both longitudinal sides and both lateral sides. No damage was noted from this test.

**4. INCLINE-IMPACT TEST.** Test Unit #2 was incline-impacted on all four sides with the pallet impacting the stationary wall from a distance of 8 feet. No additional problems were encountered.

**5. FORKLIFTING TEST.** Test Unit #2 was lifted from the end of the pallet on the forks of the forklift truck and carried over the hazard course three times with no damage or instability noted. The test unit was lifted from the opposite end of the pallet and the above steps accomplished with no problems encountered.

**6. PALLET TRUCK TEST.** Test Unit #2 was lifted and transported a distance of 50 feet and lowered. These steps were repeated for each side of the pallet with no problems noted.

**7. SLING COMPATIBILITY TEST.** Test Unit #2 was sling compatibility tested by slinging the container with two, 10-foot slings through the sling notches at the skids. No problems were encountered during the lifts.

**8. DISASSEMBLY TEST.** During the disassembly of Test Unit #2 no additional problems were noted.

**9. CONCLUSION.** Test Unit #2 passed all required tests.

## **PART 6 – DRAWINGS**

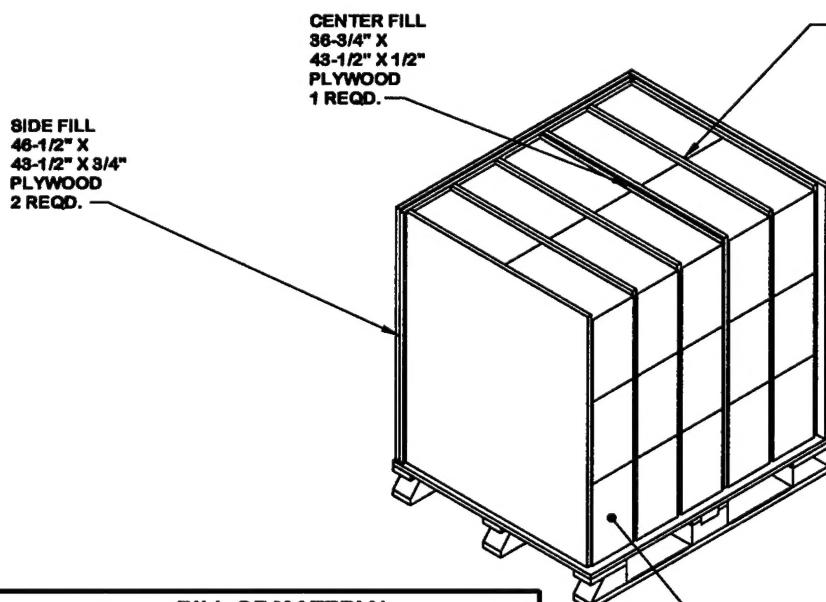
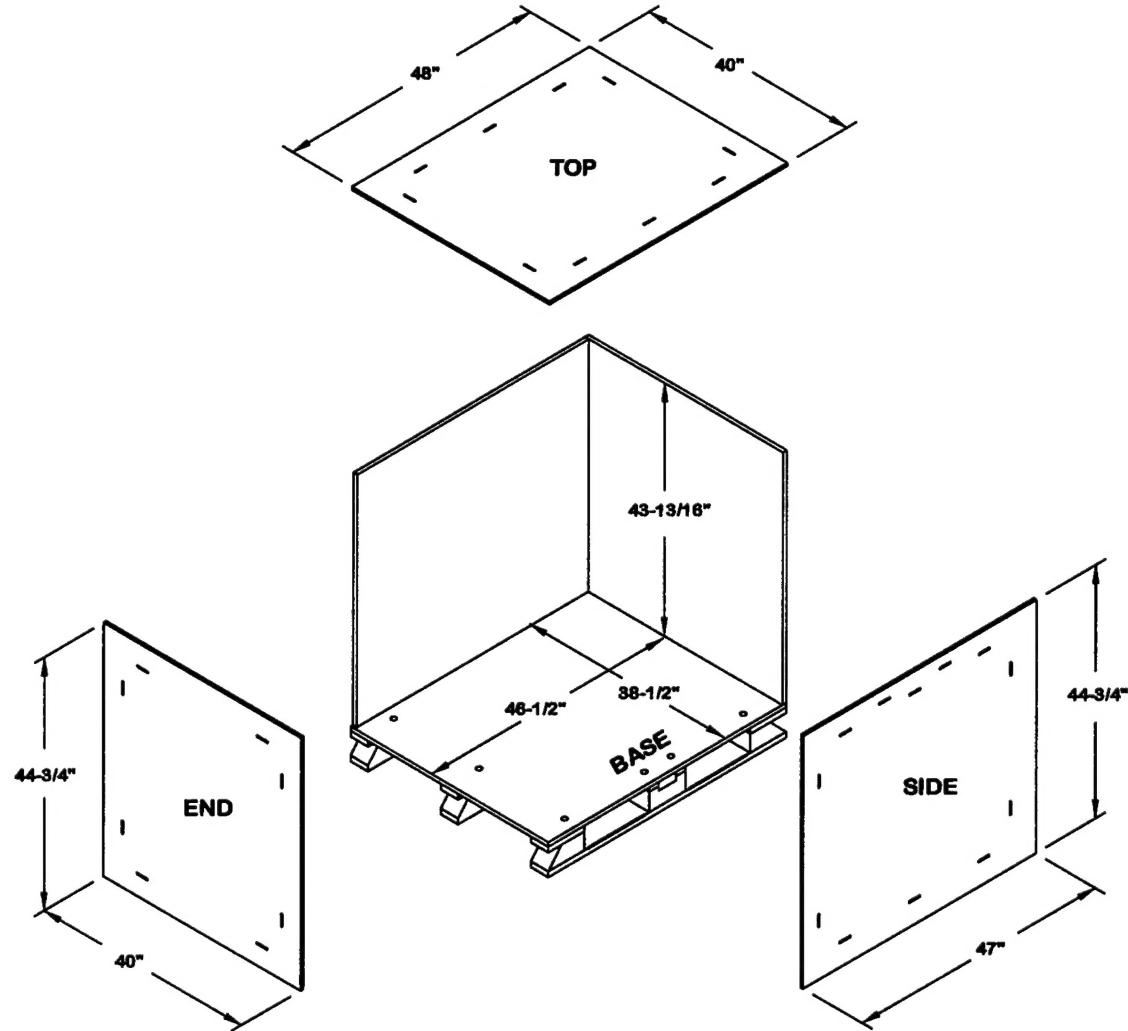
The following test sketches represent the load configuration that was subjected to the test criteria.

# **MIL-STD 1660 TESTING OF THE SURE-LOK STYLE II CONTAINER**

**THIS THREE PAGE DOCUMENT DEPICTS PROCEDURES FOR UNITIZING  
M548 CONTAINERS IN THE SURE-LOK STYLE II CONTAINERS.**

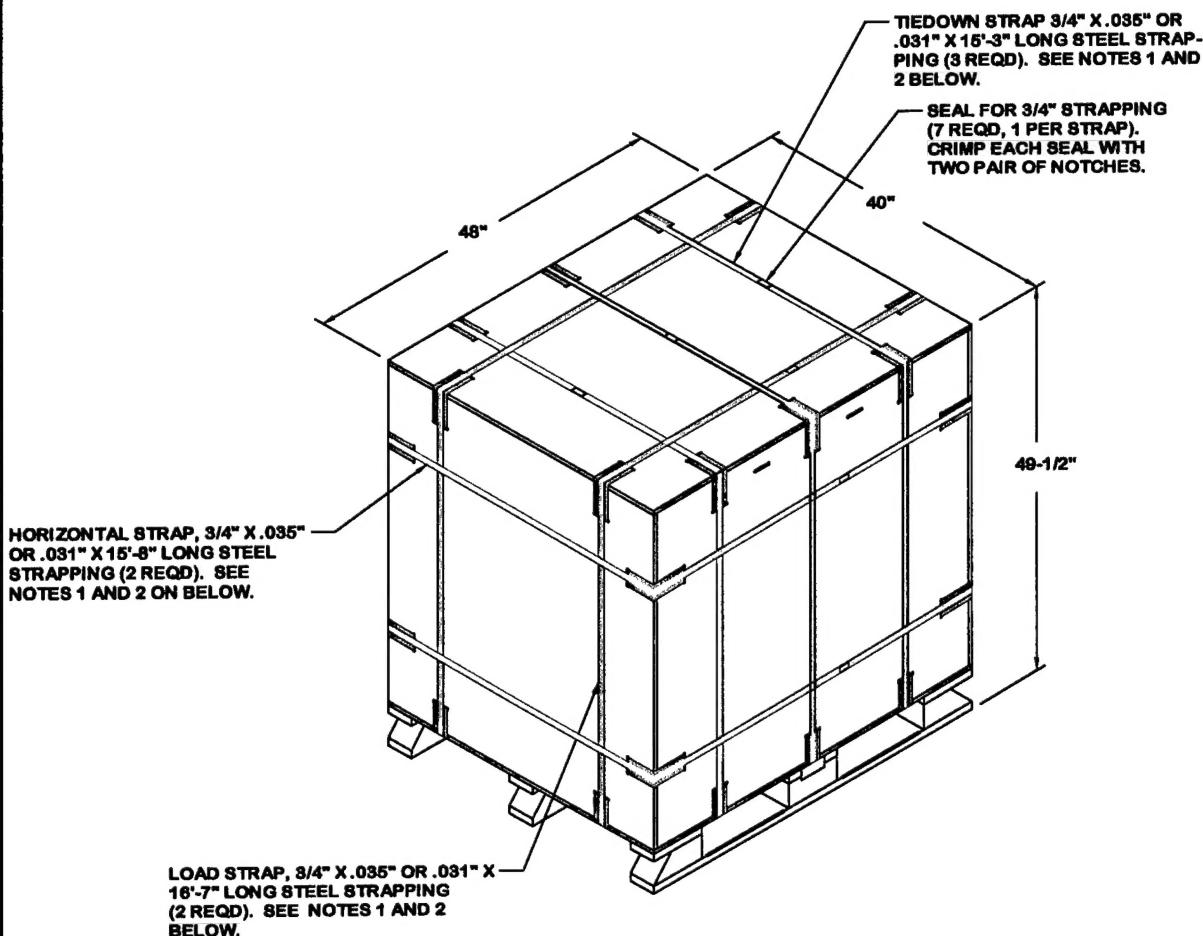
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**Gregory L. Willis  
Acting Chief, Transportation Engineering Division**



<b>BILL OF MATERIAL</b>			
M548 BOXES AT 118 LB EACH	- - - 30 REQD	- - -	3540 LBS
PLYWOOD, 3/4"	- - - - - 94.55'	REQD	- - - 195 LBS
PLYWOOD, 1/2"	- - - - - 11.01'	REQD	- - - 15 LBS

M548 METAL BOX  
WEIGHED TO 118 LBS EACH  
30 REQD.



**PALLET UNIT**  
**SURE-LOK STYLE II**  
**UNIT DATA**

30 M648 BOXES AT 118 LBS EACH	- - - - -	3,750 LBS
DUNNAGE	- - - - -	10 LBS
PALLET BOX	- - - - -	??? LBS
TOTAL WEIGHT	- - - - -	4, ??? LBS
CUBE	- - - - -	55.8 CU FT

**NOTES:**

1. WHEN APPLYING ANY STRAP, CARE MUST BE EXERCISED TO ASSURE THAT THE END OF THE STRAP ON THE UndERSIDE OF THE JOINT EXTENDS AT LEAST 6" BEYOND THE SEAL. THE EXTRA MINIMUM LENGTH OF STRAP IS REQUIRED TO PERMIT SUBSEQUENT TIGHTENING OF LOOSENERED STRAPPING.
2. INSTALL EACH HORIZONTAL, LOAD, AND TIEDOWN STRAP TO BE LOCATED AS SHOWN. HORIZONTAL STRAPS MUST BE TENSIONED AND SEALED PRIOR TO THE APPLICATION OF TIEDOWN AND LOAD STRAPS. LOAD STRAPS MUST BE TENSIONED AND SEALED AFTER THE HORIZONTAL STRAPS AND PRIOR TO THE TIEDOWN STRAPS.

<b>BILL OF MATERIAL</b>			
PALLET BOX, SURE-LOK	- - - - -	1 REQD	- - - - -

PALLET BOX, SURE-LOK - - - - - 1 REQD - - - - - ??? LBS  
 STEEL STRAPPING, 3/4" - - 110.25' REQD - - - - 9.84 LBS  
 SEAL FOR 3/4" STRAPPING - - - - 7 REQD - - - - - NIL